

## CLAIMS

1. An encoding device for adding an error correction code parity to an input data sequence, comprising:

5 a first code encoding unit for adding a binary error correction code parity to each of a plurality of first data blocks into which the input data sequence is divided; and

10 a second code encoding unit for adding a symbol error correction code for correcting an error by a symbol unit of a predetermined length to each of a plurality of second data blocks into which the input data sequence is divided in a form different from that of the plurality of first data blocks,

15 wherein the number of bit errors to be corrected per total number of bits of the first data block to which the binary error correction code parity is added is larger than the number of bit errors to be corrected per total number of bits of the second data block to which the symbol error correction code parity is added.

20 2. An encoding device according to claim 1, wherein the second code encoding unit selects partial data from each of the plurality of first data blocks to divide the input data sequence into the plurality of second data blocks.

25 3. An encoding device according to claim 1, wherein when a total number of bits of the first data block to which the binary error correction code parity is added is set to  $n$ , a minimum distance between codes of the first data block is set to  $d$ , a length of the second data block to which the symbol error correction code is added is set to  $N$  symbol, a

minimum distance between codes of the second data block is D, and a total number of bits of the symbol is m, the first code encoding unit and the second code encoding unit respectively add the binary error correction code parity and  
 5 the symbol error correction code parity to each of the plurality of first data block and second block to satisfy the following inequality:

[Mathematical 1]

$$\frac{d-1}{2n} > \frac{D-1}{2mN}$$

10 4. An encoding device according to claim 3, wherein when the total number of bits of the first data block is n, and the total number of bits of the symbol is m, the first code encoding unit and the second code encoding unit respectively add the binary error correction code and the symbol error  
 15 correction code to each of the plurality of first data block and second block where n is an integer multiple of m.

5. An encoding device according to claim 1, wherein the first code encoding unit adds, as the binary error correction code parity, a code having an error detection  
 20 function for a larger number of bit errors than the number of bit errors to be corrected by the binary error correction code parity.

6. An encoding device according to claim 1, wherein concatenated codes are added in which each of the plurality  
 25 of first data blocks becomes a connected part of the input data sequence, the first code encoding unit adds, as an inner code of the concatenated codes, the binary error correction code parity to the first data block, and the

second code encoding unit adds, as an outer code of the concatenated codes, the symbol error correction code parity to the second data block.

7. An encoding device according to claim 1, wherein the  
5 second code encoding unit adds, as the symbol error correction code parity, a Reed-Solomon code parity to the second data block.

8. An encoding device according to claim 1, wherein the  
10 first code encoding unit adds, as the binary error code parity, a code having a burst error detection function to the first data block.

9. An encoding device according to claim 8, wherein the binary error correction code parity is capable of double-bit error correction.

15 10. A decoding device for correcting errors of an encoded data sequence to which an error correction code parity is added, comprising:

a storage unit for storing the encoded data sequence;

a first error correction unit for correcting an error  
20 of each of a plurality of first data blocks, into which the encoded data sequence is divided, by minimum distance decoding of a binary error correction code; and

a second error correction unit for correcting an error  
25 of each of a plurality of second data blocks, into which the encoded data sequence is divided in a form different from that of the plurality of first data blocks, by minimum distance decoding of a symbol error correction code for

error correction by a symbol unit of a predetermined length,  
 wherein the number of bit errors to be corrected by  
 the binary error correction code per total number of bits of  
 the first data block is larger than the number of bit errors  
 5 to be corrected by the symbol error correction code per  
 total number of bits of the second data block.

11. A decoding device according to claim 10, wherein when a  
 total number of bits of the first data block is set to n, a  
 minimum distance between codes of the first data block is  
 10 set to d, a length of the second data block is set to N  
 symbol, a minimum distance between codes of the second data  
 block is D, and a total number of bits of the symbol is m,  
 the first error correction unit and the second error  
 correction unit execute error correction by the binary error  
 15 correction code and the symbol error correction code  
 respectively to satisfy the following inequality:

[Mathematical 2]

$$\frac{d-1}{2n} > \frac{D-1}{2mN}$$

12. A decoding device for correcting errors of an encoded  
 20 data sequence to which an error correction code is added,  
 comprising:

a storage unit for storing the encoded data sequence;  
 a first error correction unit for correcting an error  
 of each of a plurality of first data blocks, into which the  
 25 encoded data sequence is divided, by minimum distance  
 decoding of a binary error correction code;

a second error correction unit for correcting an error  
 of each of a plurality of second data blocks, into which the  
 encoded data sequence is divided in a form different from

that of the plurality of first data blocks, by minimum distance decoding of a symbol error correction code for error correction by a symbol unit of a predetermined length;

5 a below bounded distance decoding control unit for causing the first error correction unit and the second error correction unit to respectively correct errors having smaller distance than limit error correction capabilities of the binary error correction code and the symbol error correction code; and

10 a bounded distance decoding control unit for causing, if determination is made that the errors are not corrected by the below bounded distance decoding control unit, each of the first error correction unit and the second error correction unit to correct errors by using the limit error correction capability of each of the binary error correction code and the symbol error correction code.

13. A decoding device according to claim 12, wherein the binary error correction code has a burst error detection function and a burst error correction function, the below  
20 bounded distance decoding control unit further causes the first error correction unit to detect burst errors, and the bounded distance decoding control unit further causes the first error correction unit to correct the burst errors.

14. A decoding device according to claim 12, wherein the  
25 below bounded distance decoding control unit causes each of the first error correction unit and the second error correction unit to correct the errors of a distance smaller than the limit error correction capability by a predetermined number of times, and the bounded distance

decoding control unit causes, if determination is made that the errors of the distance smaller than the limit error correction capability by the predetermined number of times are not corrected, each of the first error correction unit  
5 and the second error correction unit to correct the errors by using the limit error correction capability.

15. An encoding method for adding an error correction code parity to an input data sequence, comprising:

a first code encoding step for adding a binary error  
10 correction code parity to each of a plurality of first data blocks into which the input data sequence is divided; and

a second code encoding step for adding a symbol error correction code for correcting an error by a symbol unit of a predetermined length to each of a plurality of second data  
15 blocks into which the input data sequence is divided in a form different from that of the plurality of first data blocks,

wherein the number of bit errors to be corrected per total number of bits of the first data block to which the  
20 binary error correction code parity is added is larger than the number of bit errors to be corrected per total number of bits of the second data block to which the symbol error correction code parity is added.

16. A decoding method for correcting errors of an encoded  
25 data sequence to which an error correction code parity is added, comprising:

a storage step for storing the encoded data sequence;

a first error correction step for correcting an error of each of a plurality of first data blocks, into which the

encoded data sequence is divided, by minimum distance decoding of a binary error correction code; and

5 a second error correction step for correcting an error of each of a plurality of second data blocks, into which the encoded data sequence is divided in a form different from that of the plurality of first data blocks, by minimum distance decoding of a symbol error correction code for error correction by a symbol unit of a predetermined length, wherein the number of bit errors to be corrected by  
10 the binary error correction code per total number of bits of the first data block is larger than the number of bit errors to be corrected by the symbol error correction code per total number of bits of the second data block.

17. A decoding method for correcting errors of an encoded data sequence to which an error correction code is added,  
15 comprising:

a storage step for storing the encoded data sequence;

a first below bounded distance decoding step for  
20 executing error correction of minimum distance decoding by an under-limit error correction capability of a binary error correction code for each of a plurality of first data blocks into which the encoded data sequence is divided;

a second below bounded distance decoding step for  
25 executing error correction of minimum distance decoding by an under-limit error correction capability of a symbol error correction code for error correction by a symbol unit of a predetermined length for each of a plurality of second data blocks into which the encoded data sequence is divided in a form different from that of the plurality of first data  
30 blocks;

a determination step for determining whether the errors of the encoded data sequence are corrected or not in the first below bounded distance decoding step and the second below bounded distance decoding step; and

5 a bounded distance decoding step for executing, if determination is made that the errors of the encoded data sequence are not corrected, error correction of minimum distance decoding by a limit error correction capability of each of the binary error correction code and the symbol  
10 error correction code.

18. A program for causing a computer to add an error correction code parity to an input data sequence, realizing by the computer:

a first code encoding unit for adding a binary error  
15 correction code parity to each of a plurality of first data blocks into which the input data sequence is divided; and

a second code encoding unit for adding a symbol error correction code for correcting an error by a symbol unit of a predetermined length to each of a plurality of second data  
20 blocks into which the input data sequence is divided in a form different from that of the plurality of first data blocks,

wherein the number of bit errors to be corrected per total number of bits of the first data block to which the  
25 binary error correction code parity is added is larger than the number of bit errors to be corrected per total number of bits of the second data block to which the symbol error correction code parity is added.

19. A program for correcting errors of an encoded data



sequence to which an error correction code is added by a computer, realizing by the computer:

a storage unit for storing the encoded data sequence;

5 a first error correction unit for correcting an error of each of a plurality of first data blocks, into which the encoded data sequence is divided, by minimum distance decoding of a binary error correction code; and

10 a second error correction unit for correcting an error of each of a plurality of second data blocks, into which the encoded data sequence is divided in a form different from that of the plurality of first data blocks, by minimum distance decoding of a symbol error correction code for error correction by a symbol unit of a predetermined length,

15 wherein the number of bit errors to be corrected by the binary error correction code per total number of bits of the first data block is larger than the number of bit errors to be corrected by the symbol error correction code per total number of bits of the second data block.

20. A program for correcting errors of an encoded data sequence to which an error correction code is added by a computer, realizing by the computer:

storage unit for storing the encoded data sequence;

25 a first error correction unit for correcting an error of each of a plurality of the first data blocks, into which the encoded data sequence is divided, by minimum distance decoding of a binary error correction code;

30 a second error correction unit for correcting an error of each of a plurality of second data blocks, into which the encoded data sequence is divided in a form different from that of the plurality of first data blocks, by minimum

distance decoding of a symbol error correction code for error correction by a symbol unit of a predetermined length;

5 a below bounded distance decoding control unit for causing the first error correction unit and the second error correction unit to respectively correct errors having smaller distance than limit error correction capabilities of the binary error correction code and the symbol error correction code; and

10 a bounded distance decoding control unit for causing, if determination is made that the errors are not corrected by the below bounded distance decoding control unit, each of the first error correction unit and the second error correction unit to correct errors by using the limit error correction capability of each of the binary error correction code and the symbol error correction code.

21. A program recording medium for causing a computer to add an error correction code parity to an input data sequence, the program realizing by the computer:

20 a first code encoding unit for adding a binary error correction code parity to each of a plurality of first data blocks into which the input data sequence is divided; and

25 a second code encoding unit for adding a symbol error correction code for correcting an error by a symbol unit of a predetermined length to each of a plurality of second data blocks into which the input data sequence is divided in a form different from that of the plurality of first data blocks,

30 wherein the number of bit errors to be corrected per total number of bits of the first data block to which the binary error correction code parity is added is larger than

the number of bit errors to be corrected per total number of bits of the second data block to which the symbol error correction code parity is added.

22. A program recording medium for correcting errors of an encoded data sequence to which an error correction code is added by a computer, the program realizing by the computer:
- a storage unit for storing the encoded data sequence;
  - a first error correction unit for correcting an error of each of a plurality of first data blocks, into which the encoded data sequence is divided, by minimum distance decoding of a binary error correction code; and
  - a second error correction unit for correcting an error of each of a plurality of second data blocks, into which the encoded data sequence is divided in a form different from that of the plurality of first data blocks, by minimum distance decoding of a symbol error correction code for error correction by a symbol unit of a predetermined length, wherein the number of bit errors to be corrected by the binary error correction code per total number of bits of the first data block is larger than the number of bit errors to be corrected by the symbol error correction code per total number of bits of the second data block.

23. A program recording medium for correcting errors of an encoded data sequence to which an error correction code is added by a computer, the program realizing by the computer:
- a storage unit for storing the encoded data sequence;
  - a first error correction unit for correcting an error of each of a plurality of the first data blocks, into which the encoded data sequence is divided, by minimum distance

decoding of a binary error correction code;

a second error correction unit for correcting an error of each of a plurality of second data blocks, into which the encoded data sequence is divided in a form different from  
5 that of the plurality of first data blocks, by minimum distance decoding of a symbol error correction code for error correction by a symbol unit of a predetermined length;

a below bounded distance decoding control unit for causing the first error correction unit and the second error  
10 correction unit to respectively correct errors having smaller distance than limit error correction capabilities of the binary error correction code and the symbol error correction code; and

a bounded distance decoding control unit for causing,  
15 if determination is made that the errors are not corrected by the below bounded distance decoding control unit, each of the first error correction unit and the second error correction unit to execute error correction by using the limit error correction capability of each of the binary  
20 error correction code and the symbol error correction code.

24. A data recording medium for recording an input data sequence and an error correction code added to the input data sequence, comprising:

a data sequence recording area for recording the input  
25 data sequence;

a first code recording area for recording a binary error code parity recorded corresponding to each of a plurality of first data blocks, into which the input data sequence is divided, and used for correcting an error of  
30 each of the plurality of first data blocks; and

a second code recording area for recording a symbol error correction code parity recorded corresponding to each of a plurality of second data blocks, into which the input data sequence is divided in a form different from that of the plurality of first data blocks, and used for correcting an error of each of the plurality of second data blocks by a symbol unit of a predetermined length,

wherein the number of bit errors to be corrected per total number of bits of the first data block to which the binary error code parity is added is larger than the number of bit errors to be corrected per total number of bits of the second data block to which the symbol error correction code parity is added.